COMPARATIVE ANALYSIS OF COST TRENDS IN THE IRON ORE INDUSTRY

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Introduction

Conditions in the iron ore market are improving after a difficult year in 1999 marked by price cuts and reduced sales volumes. Global economic recovery has led to improvement in steel production and strong demand for iron ore. Table 1 shows exports of some of the major producing countries during the first half of 2000 compared with 1999.

TABLE 1

IRON ORE EXPORTS IN 2000 JUNE HALF (Mt)

(Sources: UNCTAD,TEX, AME)

Exports	1999	2000	% Change
Australia	69.8	79.8	14.3%
Brazil	64.5	75.1	16.4%
Canada	10.2	13	27.5%
South Africa	9.6	11	14.6%
Sweden	6.5	7.7	18.5%
Mauritania	5.5	5.1	-7.3%
Total	166.1	191.7	15.4%

With the exception of Mauritania, which had a year-on-year decrease in the first half, the other producing countries registered double-digit percentage increases. The robust market is however coming off from an extremely low base in 1999. Despite a 15.4% increase in combined exports of Australia, Brazil, Canada, S. Africa, Sweden and Mauritania in the June half, there was a decline of 1.4% compared with the second half of 1999. Hence there are expectations of a slow down in the second half. Iron ore imports of Asia's four largest iron ore importing nations – Japan, China, S. Korea and Taiwan increased by an aggregate 19.5% to 128Mt in the first half of 2000 compared with the comparative period in 1999. The improving demand for iron ore comes against the backdrop of industry rationalization to capture synergies and boost efficiencies. The industry's profitability has been under pressure due to price decreases in real terms. Other cost pressures arising from environmental and land rights issues have affected the mining industry in general. For example, the environmental costs of the Australian mining industry rose from A$800m in 1995/96 to over A$1 billion in 1998/1999.

Against the background of these cost pressures, Sydney-based mining industry research and publishing house AME Mineral Economics undertakes a yearly strategic study on operational costs. The main purpose of AME's cost study is to identify the relative operating costs of the major operations to help ascertain likely future levels of

production, sales and prices. This is considered to be more useful than merely attempting to reconcile average production costs with the parent company's financial reporting, which is often a difficult task and can provide questionable accuracy or value.

Cost Components

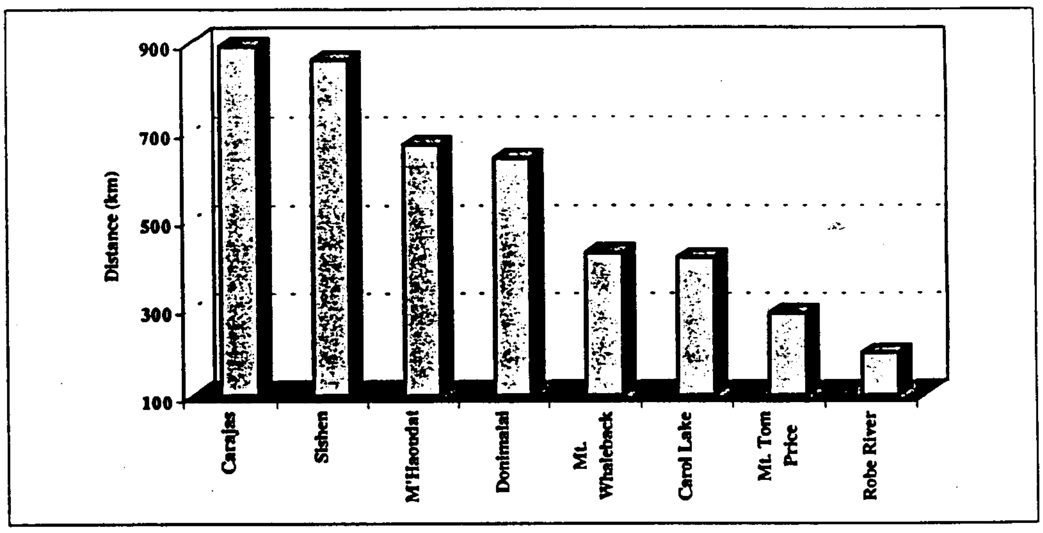
In general terms, cost components are divided into:

- Mining (drilling, blasting, loading, hauling, pit services, equipment maintenance etc.)
- Processing (crushing, screening, beneficiation etc.)
- Ore Transport to the Ports/Plants
- Port costs
- Royalties
- Ocean Freight Costs

Globally there are many substantial deposits, which will be unable to proceed to development unless they can secure efficient low-cost transport systems. In order to achieve economic viability, an iron ore producer has to provide a product that meets the requirements of the steel mills. The cost of providing the product to the steel mills also has to be competitive with other iron ore producers. Because iron ore is a bulk commodity, this means that transport cost is crucial when determining mine viability. Analysis of rail transport distances of some of the major producers is shown in Figure 1.

FIGURE 1

ORE TRANSPORTATION BY RAIL



Efficient company owned railway lines and ports used exclusively for iron ore transportation have minimised the impact of transport and port costs. Both Australia and Brazil have the advantage of well-established and efficient infrastructure systems including ports which can accommodate very large ships.

Deteriorating mine operating parameters have affected operating costs. Some of these include:

- Increasing waste to ore ratios.
- Increasing haul distances due to advancing waste dumps and deepening of the pits.
- Increasing dewatering costs.
- Increasing slope stability problems.

Despite these problems, the iron ore industry has made significant progress in cost reductions with innovations such as:

- Increased use of computerised systems to help optimise resource utilisation. An example is the use of global positioning systems to coordinate shovel output, haulage and ore blending in Mine Despatch.
- Increase in the size of loading and hauling equipment, in tandem with the increase in the scale of surface mining. Truck capacities of over 200t are very common in the iron ore industry.
- A gradual shift from electric shovels to hydraulic excavators for flexibility of ore blending, especially among Australian producers.
- Improvement in maintenance management systems with emphasis on equipment reliability and reduction of in-service breakdowns.
- Work practices reform leading to a decline in work stoppages.
- Cuts in work force to reduce cost and improve on productivity.
- Process re-engineering.

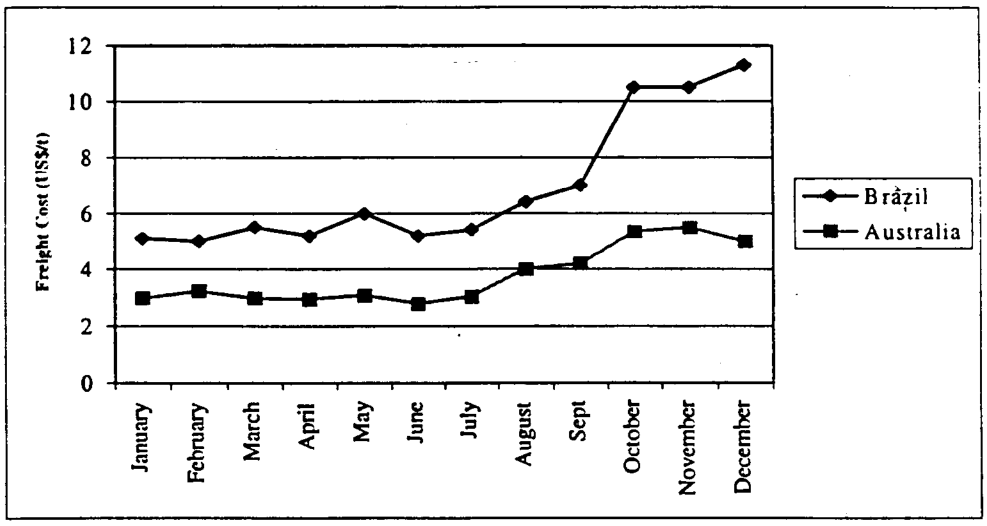
Ocean Freights

Much of the ocean freight cost is a function of geography. The distance from Hamersley's Port Dampier to the Japanese Port of Oita is around 3,400km while the distance from CVRD's port of Tubarao to Oita is about 11,100km. Hence Australia has a freight cost advantage over Brazil in Japanese markets. Similarly distances from Australian ports to Europe are far longer than Brazilian ports to Europe and hence Brazil has a freight cost advantage to that market. The operating cost of a producer in FOB terms is important to assess its competitiveness. However operating costs on C&F basis (FOB costs plus freight cost to ship the ore to the consumer) provides an assessment of the competitiveness of producers in the international market. The freight cost differential between Australia-Japan and Brazil-Japan averaged US$2.12/t during the first quarter of 1999 compared with US$5.49/t in the last quarter. The widening differential has enabled Australian producers to deliver iron ore to Japanese markets at a more competitive rate than Brazilian producers.

FIGURE 2

OCEAN FREIGHT COST: W.AUSTRALIA TO JAPAN AND BRAZIL TO JAPAN

(1999)



Steel mills require increasing stability of iron ore feed in terms of physical and chemical properties. The most economic feed mix varies from steel mill to steel mill and has been developed by years of experience and trailing of different combinations. Many steel mills use a combination of ores from several mine sources. Japanese steel mills have a purchasing policy based on freight sharing for supply from long distance sources such as Brazil. However with pressure to reduce the cost of raw material, the competitiveness of supply sources on a C&F price basis will be crucial.

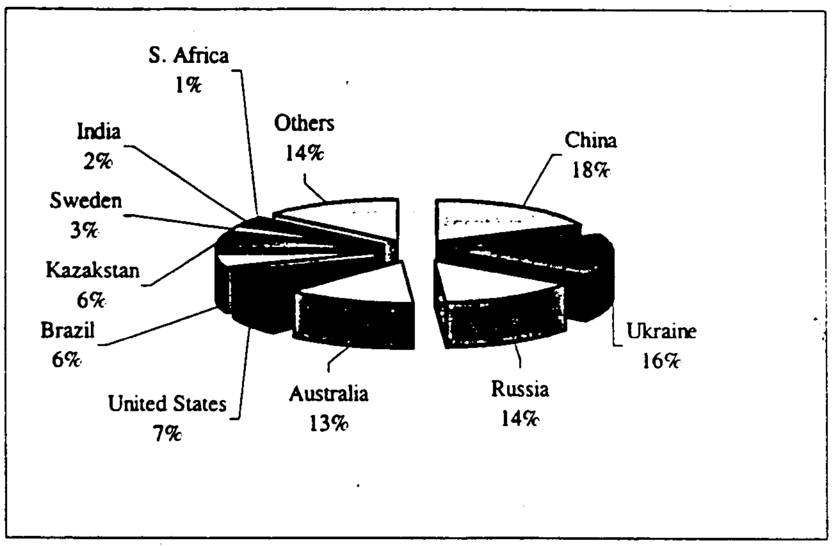
Iron Ore Resources

Although few major iron ore producing countries have accurately determined their iron ore resources and reserves, the world's total resources are known to be extremely large. World resources are estimated to exceed 800 billion tonnes of crude ore. Globally, the reserve base for iron ore is estimated at 137.6 billion tonnes. These are reserves that can be extracted economically at the time of determination. Figure 3 illustrates the reserve distribution of iron ore in the world. Even though China's reserves are about 18% of the global reserves, they are of low quality grade. The world's best quality reserves are found in Australia and Brazil, which have dominated the world seaborne trade. These estimates, which are provided by the US Geological Survey (USGS), generate cautious, conservative numbers. Exploration to prove a reserve is constrained by budget and cash flow considerations with a view to short-term planning horizons.

FIGURE 3

DISTRIBUTION OF IRON ORE RESOURCES

(Source: USGS)

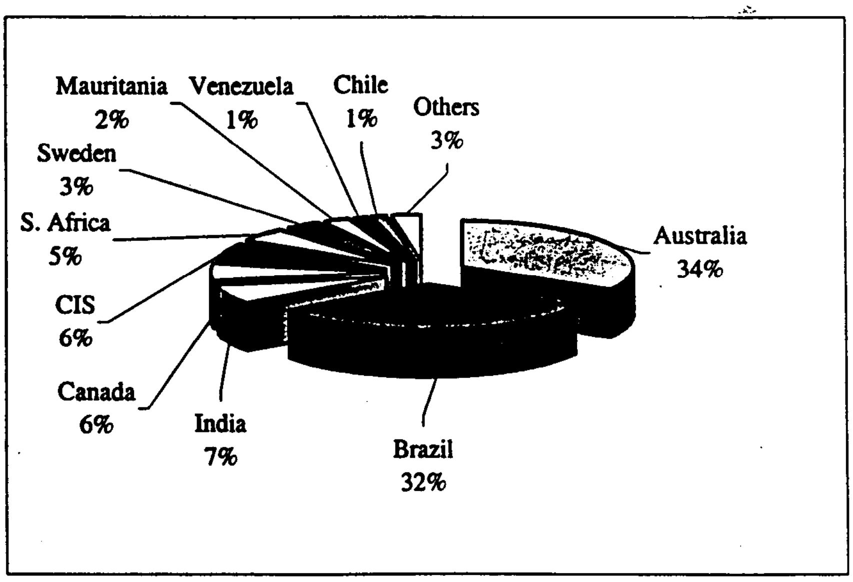


Iron Ore Exports/Imports

The production of iron ore has become more concentrated in a geographical sense with about 95% of global output now produced in only ten countries. Despite being the largest iron ore producer in gross weight of ore produced, China has a lower grade product and therefore its output in iron content is lower than that of Brazil and Australia. The two leading exporters, Australia and Brazil, produce about one-third of the world's iron ore production and export about 66% of total global exports.

FIGURE 4

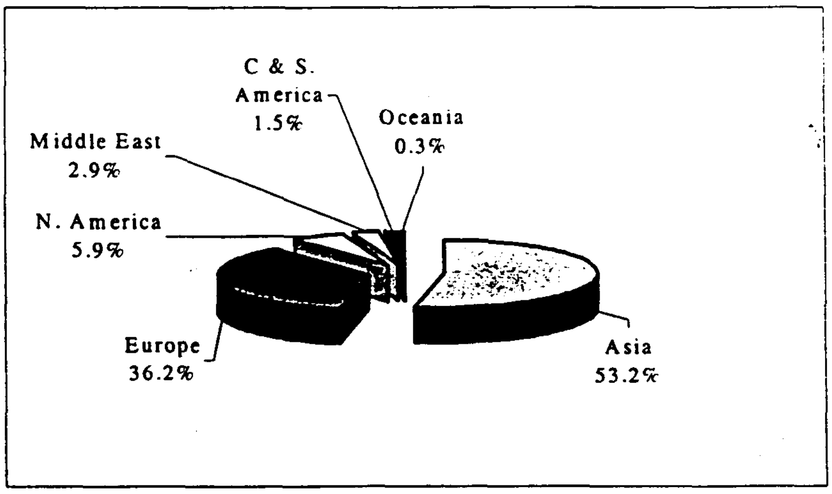
SHARE OF WORLD IRON ORE EXPORTS--1999



Most of the capacity expansions in the coming years are expected to come from Australia and Brazil. Progressive expansions will also come from medium sized mines in India, Canada, Venezuela, South Africa and Sweden. The main iron ore importing regions are Asia and Europe with 53% and 36% share respectively. Japan is the largest importer of iron ore, importing 120.1Mt in 1999, followed by China (55Mt). The major importers of iron ore in Europe include Germany (39Mt), France (20Mt) and the United Kingdom (17Mt).

FIGURE 5

SHARE OF IRON ORE IMPORTS--1999



Production Process

The mining of iron ore as practised in the major mines involves the removal of topsoil, drilling of a suitably sized volume of rock, blasting and the removal of waste and ore using shovels and trucks. Ore is then crushed to a size suitable for transport.

Ore processing includes various beneficiation and concentration processes that upgrade ores with iron content of less than 55% to improve handling and smelting behaviour and/or to remove impurities. These depend on rejecting specific types of mineral, and thus may require a finer crush than simply determined by transport needs. The mining and crushing stages inherently generate a range of particle sizes. The producer aims at all stages to minimise the generation of fines since fines cannot be fed directly into blast furnaces without first going through an agglomeration process. But, inevitably the characteristics of the ore and of the process combine to produce fines in a fairly constant proportion. Today's economics demand blast-furnace feed grades in excess of 60% Fe.

Because of the simplicity of the mining process, the transport element is often more expensive than mining. Overland transport costs are driven by distances and the nature of the terrain, but the grade and moisture content of the ore also have a considerable influence on costs of both the land and sea legs when expressed per iron unit delivered. Iron ore is mined and processed at the largest possible rates to minimise capital and operating costs.

Iron Ore Supply

Banded Iron Formations (BIFs), represent the world's most important source of iron because they commonly occur as units of enormous thickness with similarly enormous lateral extent. BIFs are characterised by fine layering, generally in the order of a half to three centimetres thick, but can also be composed of laminae. The units contain layers rich in silica (crystallized as chert or chalcedony) alternating with layers rich in iron minerals (hematite, magnetite and, to a lesser extent, siderite). The most common BIF consist of hematite layers alternating with siliceous layers.

The iron ore formations of Western Australia occur within both Archaean and Proterozoic rocks. The Yilgarn and Pilbara Cratons (large, stable geological masses) of Western Australia are Archaean in age and host substantially sized deposits of iron ore. In 1999, Australia exported 147.8Mt of iron ore, making it the world's largest exporter. The bulk of iron ore production in Australia comes from the Pilbara region of Western Australia, which is also the largest supplier of lumps in the iron ore market. In recent years, Australian producers have been reducing the extraction rate of the premium quality lump ore to slow down its depletion rate.

The development of the iron ore industry in the Pilbara was based on the Premium Brockman ores, which provide a high lump ore with high iron ore content and low phosphorous and alumina. The ore is physically strong and highly reducible in blast furnaces. Both Rio Tinto's Tom Price and BHP's Mt. Whaleback have massive resources of Brockman ore. These two operations have been carefully conserved by the addition of satellite orebodies. A common phenomenon is to blend some Marra Mamba type ore with Brockman ore to extend the life of the low phosphorus Brockman ore at Tom Price and Mt. Whaleback. The development of West Angelas project brings in the new generation Marra Mamba ore that will be sold as a stand-alone product. Pisolitic deposits at BHP Yandi, Rio Tinto Yandi and Robe River have gained market acceptance due to their good sintering characteristics. Import share of the pisolitic product in Japanese markets have been rising as shown in Table 2. BHP and Rio Tinto are increasing annual capacities of their Yandi deposits to 30Mt and 20Mt respectively.

TABLE 2

JAPAN'S IMPORT SHARE OF PISOLITIC ORE--JFY (Dry Mt)

(Sources: AME, TEX)

Ore Brand	1994	1995	1996	1997	1998	1999
Yandi	3.81	6.28	7.89	10.79	12.77	16.70
Robe River	16.02	15.41	15.37	14.75	15.20	16.20
Sub-Total	19.83	21.69	23.26	25.54	27.97	32.90
% of Japan's Imports	18%	19%	21%	21%	25%	29%
Total Japan's Imports	111.90	112.18	113.21	119.09	111.06	112.20

The cost competitiveness of Brazil has improved with the partial privatization of CVRD, the massive devaluation of the local currency, low labour costs, low stripping ratios and a series of operational improvements. However, Australia supplies iron ore to Asian markets on a more competitive CIF basis by virtue of its close proximity.

Brazil is the second largest producer of iron ore after China, but becomes the largest on iron unit basis because of the high iron content. The largest deposit occurs in Minas Gerais state, located in the south east of the country, across an area of some 7,000km^2 called the "Iron Quadrilateral". Brazil's aggregate production has increased from 135Mt in 1987 to 146Mt in 1992 and 189Mt in 1999 (China currently produces around 265Mt of low-grade iron ore concentrate, but this concentrate contributes far fewer Fe units to the steel industry). Brazil supports a considerable domestic steel industry, but over the same period its iron ore exports have grown in a similar fashion: from 97.3Mt in 1987, via 106.0Mt in 1992 to 140.2Mt in 1999. Buoyed by its lower costs following the devaluation of the Real, over the long term Brazil will remain arguably the world's largest iron ore producer.

Brazilian ores are more friable than Australian. In consequence a high proportion of fines is produced. Some of the fines are processed into pellets in Brazil. By virtue of Brazil's Atlantic seaboard, Western Europe is the primary market for Brazilian ores. However, in 1999 exports to Asia exceeded Europe by 1.5Mt (Brazil delivered 57.7Mt to Asia and 56.2Mt to W. Europe). Average ore grade analysis based on fines of main ore brands into Japan indicates that Carajas fines are the most suitable ore brand for low slag operations. The combined content of silica and alumina for Carajas fines is significantly lower than the other brands as shown in Table 3. The low impurity content of Carajas fines has led to increase in imports into the Japanese market. In 1999, sales of Carajas fines improved 9% to 11.4Mt.

TABLE 3

MAJOR ORE BRANDS INTO JAPAN : AVERAGE FOR 1998

(Source : TEX)

Ore Brand	Fe	Silica	Alumina	Phosphorus	Silica & Alumina
Carajas	67.45%	0.70%	0.84%	0.035%	1.54%
Itabira	65.45%	4.45%	0.85%	0.028%	5.30%
Mt. Newman	63.75%	3.87%	2.20%	0.067%	6.07%
Hamersley	63.46%	3.41%	2.17%	0.072%	5.58%
BHP-Yandi	58.50%	4.86%	1.31%	0.041%	6.17%
Robe River	57.42%	5.25%	2.60%	0.042%	7.85%

Company Cost Reduction Initiatives

Iron Ore Companies continue to re-evaluate work practices to provide a basis for continuous operating improvement. Some examples of company cost reduction initiatives are outlined.

Rio Tinto

Rio Tinto's mines have undergone a substantial redesign, to simplify production and management processes and thereby create greater efficiency and productivity. The project, termed the "core process redesign", conceptually operates Hamersley's six mines as "one mine". The mines are part of one integrated production process in contrast with the previous system where the mines operated as individual entities, with their own production schedules, targets and management structures. The new operating philosophy optimises Hamersley's resources, resulting in improved efficiency, lower costs and efficient asset utilisation. In 1999, Rio Tinto improved its productivity with 40% less mobile equipment, underpinning some of the cost reductions at its mines. There were also savings to the tune of A$100 million below the relative 1996 cost levels, which were achieved two years earlier than planned.

Rio Tinto acquired North Ltd in order to capture synergies and boost efficiencies. Cost reduction initiatives at the Robe River mine include improved powder factor in blasting and reduced mining costs through electronic mapping. Robe River's organisational restructuring at the mine and railroad divisions has resulted in a reduction of the workforce and contributed to improved productivity. The mine enjoys sound industrial relations, which has ensured high labour productivity. In Rio Tinto's IOC operation, approval has been granted for the replacement of its haulage trucks as part of the company's load and haul strategy. The aging T-2200s are being replaced with 240-ton capacity trucks. It is implementing a fundamental change to its cost structure through an upgraded asset base and improved work practices. The workforce will be reduced by about 25% as part of the strategy to boost productivity.

BHP

Re-examination of mine plans has also led to significant changes at the Mount Whaleback Mine. Design changes have been made to the mine's pushbacks to defer waste movement, reduce the stripping ratio and improve ore exposure. Another cost improvement initiative at Mount Whaleback is the performance increase and improved application of the mine's Modular Mining System. The despatch system provides the optimum equipment match for loading and hauling and provides operator performance feedback. In November 1999 BHP Iron Ore proposed a system of individual workplace agreements for its employees with the aim of increasing flexibility and boosting productivity. BHP Iron Ore is also working towards eliminating port handling and stockpiling inefficiencies and reducing cycle times for trains. The company reduced staffing levels by about 25% in 1999. A long-term study at the trainload out tunnel chute at Mount Whaleback has already led to a 10% increase in iron ore carried per ore car without increasing loading time.

CVRD

CVRD has entrenched its position as the largest producer and exporter of iron ore by acquiring Socoimex and Samitri and going into joint ownership with BHP for the Samarco mine. The rationale is to capture synergies, boost production and accelerate cost reductions and efficiency improvements. Aided by the partial privatisation and the consequent operational reforms, the devaluation of the Brazilian real and low waste to ore ratios, CVRD has become a low cost producer. Due to deepening of the

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RESUME

Henry Antwi is a Principal Analyst and Mining Engineer and manages the iron ore research division at AME Mineral Economics. Henry has travelled extensively during his academic pursuit and working experience. He did his Bachelors Degree in Mining Engineering at the Camborne School of Mines in England, Masters Degree in Mining Engineering and Mineral Economics at the Colorado School of Mines in the USA and a Graduate Diploma in Business Administration at Curtin University in Australia. He is also a Chartered Engineer with the Institute of Mining and Metallurgical Engineers (IMM, England).

Henry's mining industry experience covers the gold, diamond, coal and iron ore sectors in Ghana, Canada, USA and Australia. He worked with Ashanti Goldfields in Ghana for five years as a Mine Engineer in the Technical Services Department. He was also a member of the Ashanti Mine Expansion Team where he was responsible for the open-pit and underground interface designs. During his employment at Ashanti, Henry also worked briefly with Campbell Red Lake Mine in Canada and Datamine International in England on technical exchange programmes.

Henry left Ashanti in 1991 to work as a Teaching Assistant and pursue his Masters Degree in Mining Engineering and Mineral Economics at the Colorado School of Mines. He joined BHP Minerals in January 1994 at the US Coal Operations and worked in various roles including, Projects Engineer, Reclamation Engineer, Quality Control Engineer and Pre-Stripping Engineer. Henry was transferred to BHP's Iron Ore Division in Australia in 1996 and worked in mine projects, long term planning and operational analysis. He joined AME Mineral Economics at the Sydney Head Office in January 1999. His publications and conference presentations cover a wide variety of topics in operational planning, commodity markets, mineral resource development and investment analysis.